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INTENSE EXCITATION SOURCE FOR HIGH POWER LASER(U)
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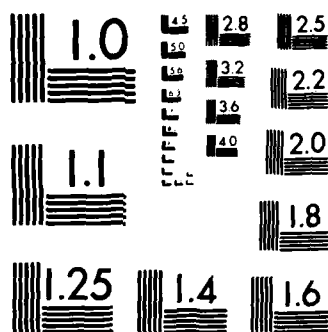
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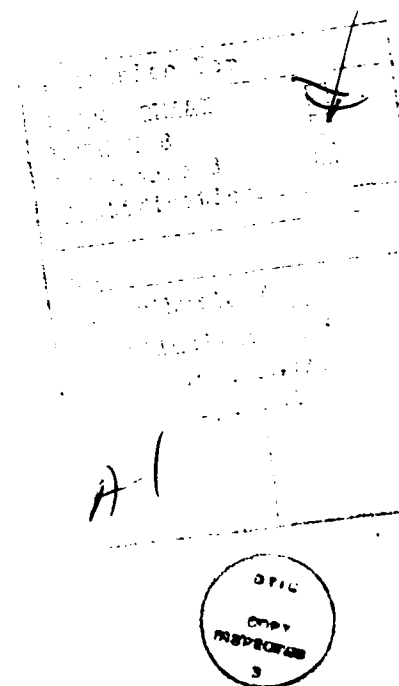
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capacitor bank. The plasma temperature $7,250^{\circ}\text{K}$ was obtained when the HCP was operated for the optimum laser output. The spectral efficiency of the absorbed radiation was 22% or 83% of the maximum efficiency of the optimum blackbody source.

A high power iodine laser ($>40\text{kW}$) has also been pumped with the HCP whose fill gas of argon was at 1.7 atm. A quadratic increase of the iodine laser output as the fill gas pressure increased. High pressure operation of the HCP at upto 1.7atm resulted in significant increase in uv emission.

Finally the enhancement of LD490 dye laser output energy has been attempted with the spectrum conversion of HCP pumping light. The result indicates that the secondary dye BBQ enhanced laser output of LD490 dye by a factor of two. However, further experiment is needed to make a definite conclusion.

Therefore, the HCP source can be operated to match the most efficient spectrum for visible, uv and even x-ray laser pumping at very high input level.



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An Intense Excitation Source for High Power Lasers

Final Report

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Hampton University
Dept of Physics and Engineering
Hampton, Va 23668

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Abstract

A high power blue-green dye laser has been pumped with an array of multiple-stage hypocycloidal-pinch (HCP) plasmas. The maximum untuned laser power obtained with LD490 dye exceeded 230kW with a pulse width of $1.0\mu\text{s}$ (FWHM). The HCP pump source was energized by up to 4.2kJ energy which was stored in the capacitor bank. The plasma temperature $7,250^{\circ}\text{K}$ was obtained when the HCP was operated for the optimum laser output. The spectral efficiency of the absorbed radiation was 22% or 83% of the maximum efficiency of the optimum blackbody source.

A high power iodine laser ($>40\text{kW}$) has also been pumped with the HCP whose fill gas of argon was at 1.7 atm. A quadratic increase of the iodine laser output as the fill gas pressure increased. High pressure operation of the HCP at upto 1.7atm resulted in significant increase in uv emission.

Finally the enhancement of LD490 dye laser output energy has been attempted with the spectrum conversion of HCP pumping light. The result indicates that the secondary dye BBQ enhanced laser output of LD490 dye by a factor of two. However, further experiment is needed to make a definite conclusion.

Therefore, the HCP source can be operated to match the most efficient spectrum for visible, uv and even x-ray laser pumping at very high input level.

I. Introduction

A number of coaxial flashlamp dye lasers show successful operation at an average power level of 100W with an efficiency of approximately 0.5%.¹⁻³ However the lifetime of a coaxial flashlamp severely reduces when operated at a high average power. This is mainly due to the explosion limit of the quartz envelopes used in its construction.

A new light source developed by Lee et al⁴, called a hypocycloidal pinch (HCP) plasma device produces intense uv emission. Consequently the HCP device has a significant advantages over a flashlamp for pumping high power laser whose absorption band lies in the uv region. The major advantages of the HCP device as a light source over the flashlamp are: 1. longer useful life because of virtually no explosion limit on the input energy, 2. faster rise time because of lower inductance (a few nanohenry), 3 operational condition. Detailed description of these advantages have been reported elsewhere.⁴

The investigation was carried out to find optimum condition of the HCP device for pumping an atomic iodine laser, rhodamine 6G dye and LD490 dye laser by spectroscopic investigation of the pump band (200-300nm), the laser output power energy dependence of the input electrical energy, type of gas, the filling gas pressure and laser cavity parameter. Subsequently an atomic iodine laser, rhodamine 6G dye and LD490 dye laser have been successfully excited by the HCP plasma array operated with high pressure heavy gas filling mode. Finally the laser system with the HCP device have been tested for enhancement of the laser output through the spectrum conversion method. Experimental results are discussed in detail in chapter III.

II. Hypocycloidal-Pinch Plasma Array

The basic unit of the HCP apparatus consists of three disk electrodes and two insulating rings which form two annular discharge chambers. Detailed description of the apparatus and near uv emission from the plasma are reported in Ref. 4 and 5. In brief, the two discharge chambers provide radially compressing current sheets by the self-induced $J \times B$ force or the pinch mechanisms. When the current sheets arrive near the center hole, the plasma density and temperature are increased enormously by the Joule heating of the current and shock compression of the plasma. The peak value of these parameters are determined by the initial conditions of operation. The rise time of the light pulse following the current sheet is very short ($< 1 \mu s$) and the operating power level (or the linear density on the axis) of the HCP apparatus can be at least two orders of magnitude higher than that (0.5 kJ/cm) of a typical xenon flashlamp.

The HCP apparatus can be operated under widely different conditions and the plasmas thus produced vary in wide ranges of the electron temperature T_e and density n_e , for example, a low pressure mode with a fill pressure less than 1 Torr of deuterium, a dense plasma focus with $T_e \approx 1$ keV and $n_e \approx 10^{26} m^{-3}$ is produced while a high pressure mode with fill pressure over 10 Torr of xenon forms "ring" of plasmas about the axis of the apparatus. The plasma has a relatively low temperature $T_e \approx 10$ eV but occupies a large volume with $n_e \approx 10^{23} m^{-3}$. This latter mode of operation is therefore more suitable for pumping a laser, which requires intense optical power in visible and ultraviolet bands. Furthermore, an array of any number of the plasma rings can be produced by use of multiple-stage HCP units.

In order to determine the optimum plasma temperature for pumping the LD490 dye laser, the emission spectra $I(\lambda, T)$ of blackbodies at a different temperatures are considered together with the absorption profile $\sigma(\lambda)$ of the dye as shown in figure 1. The absorptive efficiency $\eta(T)$ is defined as the ratio of the absorbed radiative power and the total blackbody radiation, or

$$\eta(T) = \left[\int_0^\infty (1 - 10^{-\epsilon(\lambda, M)\ell}) I(\lambda, T) d\lambda \right] / \left[\int_0^\infty I(\lambda, T) d\lambda \right],$$

where $\epsilon(\lambda)$ molar decadic extinction coefficient liter mol⁻¹cm⁻¹ (the absorption peaks located 300nm are ignored for the calculation.) M is molar concentration of dye, 4.6×10^{-4} mol/l. ℓ is optical path or radius of the dye cuvette, 0.4cm. $\eta(T)$ calculated numerically is shown in figure 2. The maximum efficiency $\eta_{\max} = 26\%$ is obtained for $T = 9,750^\circ\text{K}$. It is interesting to note that the intensity peak of this blackbody spectrum is located at $\lambda = 297\text{nm}$ according to Wien's displacement law, while the absorption peak LD490 dye is $\lambda = 400\text{nm}$ to result in the maximum efficiency. This result comes from the fact that the absorption efficiency defined above include not only the spectral profile of the blackbody radiation but also the absorption profile and the absorption length of the medium. The absorption efficiency used here has a considerable difference from the spectral efficiency of the radiation source commonly used by others. For example, Gusinow reported that the optimum blackbody temperature can be obtained by maximizing the spectral efficiency for a given absorption band⁸ and obtained the relation

$$T_{\text{opt}} = \frac{hc}{k} \cdot \frac{(\lambda_2/\lambda_1 - 1)}{3 \ln(\lambda_2/\lambda_1)} \cdot \frac{1}{\lambda_2}$$

where c =velocity of light, h =Planck's constant, and k =Boltzman's constant. The λ_1 and λ_2 are the wavelengths which define the absorption band. Since T_{opt}

is dependent on λ_2/λ_1 , the determination of the effective absorption band becomes important for the application to a given medium. The first absorption curve of LD490 dye has its FWHM points at $\lambda_1=370\text{nm}$ and $\lambda_2=430\text{nm}$, while the fullwidth(FW) at 0.1 maximum points at $\lambda_1=340\text{nm}$ and $\lambda_2=450\text{nm}$. The corresponding value of T_{opt} for the two wavelength sets ($12,056$ and $12,323^{\circ}\text{K}$) are considerably higher than the value obtained from our calculation which includes the absorption parameters of the same dye. Therefore one cannot universally assign the optimum blackbody temperature for a given medium but the absorption characteristics of the medium must be included in the determination of the optimum temperature of the radiation source. The color temperature measured for the HCP (20 Torr argon) used in experiment was $7,250^{\circ}\text{K}$ which has the corresponding absorptive efficiency of 22% or 83% of the maximum efficiency calculated. The use of the blackbody temperature may be justified for the fact that the high-pressure, heavy gas-mode is used for the HCP discharge. The detailed electrical characteristics of the HCP system used listed in table 1 and table 2.

III. Experiment and Results

1. Blue-green dye laser (LD490 dye)

Figure 3 shows a cross sectional view of the HCP device used for the present experiment. The device consists of seven disk electrodes which are separated by insulating ceramic glass (Macor) washers. The device utilizes a series connection of the HCP units which are connected with twenty four $1\text{-k}\Omega$ resistors to provide voltage divisions between the electrodes. The series

connection improves electrical energy dissipation in the device.

An array of the plasma rings are produced by current sheet compression occurring interelectrode spacing of the device as shown by the dotted lines in the figure 3. The laser system consists of a quartz (or Pyrex) dye cuvette and laser cavity mirror. A methanol solution of dye is continuously pumped through a quartz (or Pyrex) cuvette inserted along the axis of the HCP array. The cuvette had 3.5mm inner diameter and 82.5mm length. The dye solution used in this experiment was prepared with a 1:1 mixture of methanol and deionized water, and had a dye (LD490) concentration of 2.3×10^{-4} mol/l. The laser cavity mirror M_1 had a central wavelength of 490nm with a bandwidth of 60nm and a flat HR surface. The output mirror M_2 had the same central wavelength and the bandwidth but a few percent transmission and a 10m radius of curvature. D_1 and D_2 are silicon photodiode detectors with responsivity of 0.5A/W. D_2 was arranged to measure the pumping light intensity and D_1 the laser output power. A neutral density of 3 was used to attenuate the laser light incident to D_1 . Argon was used as a fill gas of the HCP and its pressure was varied from 0.33 kPa (2.5Torr) to 13.3kPa (100Torr). Sometimes xenon was also used for comparison. Figure 4 shows typical oscillogram trace of the laser signal (upper) and the pumping light intensity (lower). The HCP operating conditions of this measurement were 2.7kPa (20Torr) of argon fill gas and 1.9kJ of the electrical input energy. The rise time of the pumping light was 0.7 μ s and threshold is reached at 78% of peak intensity. The termination of the laser pulse before the pumping light pulse is decreased below the threshold intensity is apparent. The self-termination is due to the quenching by triplet state of the dye molecules. Figure 5 shows the calibrated microdensitometer traces of the photographs of the spectra from the HCP pumping light of argon and xenon fill gas respectively for both pyrex and quartz dye cuvette. The spectral

output of the HCP is very similar for both argon and xenon. The spectrum cutoff is at the wavelength of 270nm by the pyrex wall of the cuvette. However, the integrated energy output with xenon gas is 1.5 times stronger than that with argon gas. Another interesting point is that when the peak of the spectrum for argon is at 390nm which is near the absorption peak of LD490 dye, but the peak of the spectrum output with xenon is at 420nm. Figure 6 shows the laser output energy as a function of the fill gas pressure (He and Ar). The laser output increases sharply and reaches a maximum at 2.7kPa(20 Torr) of fill gas pressure (He and Ar). Thereafter the laser energy decreases as the fill gas pressure increases.

Figure 7 shows the laser output energy as a function of the electrical input energy for two different cavities; one is with a 2% transmission output mirror and a 3.5mm inner diameter quartz dye cuvette and the other with a 40% transmission output mirror and a 8mm inner diameter pyrex cuvette. The results show that the laser output energy increases linearly with the input energy up to 5kJ for all dye concentrations. However, the rate of increasing the laser output with a 40% transmission output mirror and 8mm inner diameter pyrex dye cuvette is about 68 times faster than that with a 2% transmission output mirror and a 3mm inner diameter quartz dye cuvette. The linear response of the laser output energy was attributed to the fact that the pumping light intensity is linear to the capacitor bank energy.

Figure 8 shows the dependence of the output laser energy on the dye concentration. Since the cavity loss remains constant, the ratio between the gain and loss increases as the concentration increases. The result is an increase in the laser output energy as the dye concentration increases. According to figure 8, this effect persists up to the dye concentration of

$4.6 \times 10^{-4} \text{ M/l}$. Further increase in the dye concentration, however, results in concentration quenching. Namely as the distance between two molecules decreases to 10nm or less, due to the frequent molecular collision, deexcitation takes places via nonradiative processes, thereby reducing the output laser energy. The optimum dye concentration that led to the peak laser output was $4.6 \times 10^{-4} \text{ M/l}$ when pumped with 20 Torr of argon in the HCP. No laser excitation could be obtained at dye concentration above $7 \times 10^{-4} \text{ M/l}$.

Figure 9 shows the dependence of the laser output energy on the output transmission mirror. The result indicates that the laser output increases until 40% transmission. However the further increase in the transmission results in the reduction of the laser output energy. No laser output could be obtained at the transmission above 80%. This reduction of the laser output energy is mainly attributed to the fact that the loss per pass exceeds the gain in the laser cavity and thus the further growth of the photon flux is not possible.

Figure 10 shows the laser signals of repetitive operation of the laser system. Due to the low maximum current (70mA) of the power supply used, the repetition rate was limited to 0.5 pulse per second. Each laser pulse has a peak power of 10W for the input energy 400J/pulse. In addition to a high current power supply, we found that a fill gas recirculation is necessary in order to extend the period of continuous operation.

2. Atomic Iodine laser

Near uv emission in the 200-300nm range of HCP device has also been investigated spectroscopically and applied for high power (>40kW) of atomic iodine laser excitation. High pressure operation of the HCP at upto 1.7atm

resulted in significant increases in near uv emission, indicating further up-scale may be possible. A quadratic increase of the iodine laser output was observed as the fill gas pressure increased. The input energy per gain length used here for the HCP source was 1.1kJ/inch significantly higher than the limit of conventional flashlamp and further increase of the input energy seems warranted by metallic construction of the HCP. See details in reference 5.

3. Enhancement of laser output energy through a spectrum conversion method

In order to accomplish a better energy or power coupling to the pumpband of LD490 dye from the HCP pumping light source using secondary energy converter dye, the following dyes were mixed with LD490 dye in the ethanol solution respectively: Exciton dye BBQ, PPO, LD390, α NPO etc. In another words, the converter dye absorbs light photon in a region of the HCP pump source spectrum where the lasing dye LD490 does not absorb. However, the converter dye fluoresces at the pumpband of the primary dye LD490. The the converter dye takes photons from a part of the pump spectrum that are not normally utilized in the lasing process and converts these photons to a region where they can be absorbed by the lasing dye. The overall effect of such a scheme provides more photons in the laser dye absorption and reduces effectively the dye lasing threshold.

At present time experimetnal results indicate that BBQ dye in ehtanol solution increases the laser ouptut energy of LD490 dye by about about 200% as compared with that of LD490 dye alone. However, the result of enahncement by BBQ dye could not be reproduced because of the very poor solubility of BBQ dye in ethanol dolution. On the other hand LD390, NPO, PPO dye in ethanol solution have decreased or have not enhanced the laser output energy of LD490 dye. This was due to the slight overlap (1%) of the absorption band with the edge of LD490 fluorescence band, or other factors. In order to overcome the

poor solubility of BBQ dye in ethanol solution for spectrum conversion, other blue-green dye such as Coumarin 500, 503 and secondary converter dye BBQ, PBB0 in P-dioxane solution will be tested for enhancement through spectrum conversion.

IV. Summary and Conclusion

A high power blue-green dye laser has been pumped with an array of hypocycloidal-pinch(HCP) plasmas. The HCP pump source was energized by up to 4.2kJ energy stored in the capacitor bank. The maximum argon pressure used 100 Torr with the optimum at 20 Torr. The short rise time ($<1\mu\text{s}$) of pumping light was obtained by using a small ($6\mu\text{F}$) capacitor. The laser output power and energy dependence of the input electrical energy, the type of gas, the filling pressure and the laser cavity parameters were studied with respect to the characteristics of the pumping light. The plasma temperature $7,250^{\circ}\text{K}$ was obtained when the HCP was operated for the optimum laser output. The spectral efficiency of the absorbed radiation at this temperature was 22% or 83% of the maximum efficiency of the optimum blackbody source.

Near uv emission in the 200-300nm range of hypocycloidal-pinch plasma has been measured spectroscopically and pumped a high power iodine laser (40kW). Operation at super atmospheric fill-gas pressures of argon significantly elevates the uv emission. A quadratic increase of the iodine laser output was observed as the fill gas pressure increased.

We conclude that the HCP source can be operated to match the most efficient spectrum for visible, uv and even xray laser pumping at very high input levels. It is also suitable for repetitive and high average power laser system.

V. References

1. M. E. Mack, D. B. Northern, and L. G. Crawford I. Opt. Soc. Am. 66 1106 (1976)
2. W. Glen, W. Morey, and C. M. Ferrar "High Power Dye Lasers", at 1975 IEEE/OSA Conference on Engineering and Applications, Washington D. C.
3. J. Jethwas, F. P. Schafer and J. Jamey, "A Reliable High Power Dye Laser," at 1977 IEEE/OSA Conference on Laser Engineering and Applications, Wahsington, D. C.
4. J. H. Lee, D. R. McFarland and F. Hohl, Applied Optics 19, 3343 (1980)
5. K. S. Han, C. H. Oh, D. D. Venable and J. H. Lee, Conference Proceedings IEEE 82 CH1749-1 (1982)
6. K. S. Han, D. K. Park and J. H. Lee, Virginia Journal of Science 35, 169 (1985)
7. H. Rieger, and K. Kim J. App. Phys. 52, 5381 (1981)
8. C. H. Oh, New Physics (Korean Phys. Soc.) 22, 330 (1982)
9. M. A. Gusinow, "Efficiency of Flashlamp Excited Lasers", SLA-73-0905 Sandia Lab. (1973)

VI. List of Publications and Technical Reports
generated
under ARO Grant

1. "Visible Emission of Hypocycloidal-Pinch Plasma" K. S. Han, D. D. Venable, and J. H. Lee, Conf. Record IEEE 81CH1640-2 NPS, P. 156 (1981)
2. "Dye Laser Pumped by Hypocycloidal Pinch (HCP) Discharge" K. S. Han, C. H. Oh, D. D. Venable, and J. H. Lee, Conf. Record IEEE 82CH1479-1, P.182 (1982)
3. "Near uv Emission of Hypocycloidal-Pinch (HCP) Discharge" K. S. Han, D. K. Park, D. D. Venable, and J. H. Lee, Bull. APS. Vol. 27, 1063 (1983)
4. "High Power Blue-Green Laser by Hypocycloidal-Pinch Plasma" K. S. Han, S. H. Nam, and J. H. Lee, Journal of Applied Physics 55, 4113 (1984)
5. "A High Pressure Plasma Source for pumping Atomic Iodine Lasers" K. S. Han, D. K. Park, and J. H. Lee Journal of Virginia Science 35, 169 (1984)
6. "Spectral Optimization of Hypocycloidal-Pinch Array as Laser Pump Source" J. H. Lee and K. S. Han 1984 IEEE International Conference on Plasma Science Record Page 106 (1984)

VII. List of Scientific Personnel

involved

under ARO Grant No. DAAG29-83-G-0107

K. S. Han	Principal Investigator	Oct 1, 1983 - present
J. H. Lee	Adjunct Research Prof.	Oct 1, 1983 - present
M. H. Lee	Research Associate	July 1, 1984 - present
S. C. Park	Graduate Student	June 1, 1984 - present
K. D. Song	Graduate Student	June 1, 1984 - present

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TABLE 1
Inductance of the HCP System

Total inductance L_t	149 nH
Inductance of capacitor Bank L_c	20 nH
Inductance of coaxial cable L_w	47.09 nH
Inductance of HCP L_h	18.6 nH
Others (Miscellaneous) L_m	63.31 nH

$$*L_t = L_c + L_w + L_h + L_m$$

TABLE 2
Circuit Parameter of the HCP System

Period of Oscillation T	6 μ s
Ring frequency f	167 kHz
Inductance L_t	149 nH
Resistance R	0.3128 Ω
Capacitance C	6.09 μ F
Peak current I_m	156.6 kA
Rise time	1.5 μ s
Operating voltage range	0 40 kV
Operating pressure range	1 100 Torr (Ar, Xe, He)

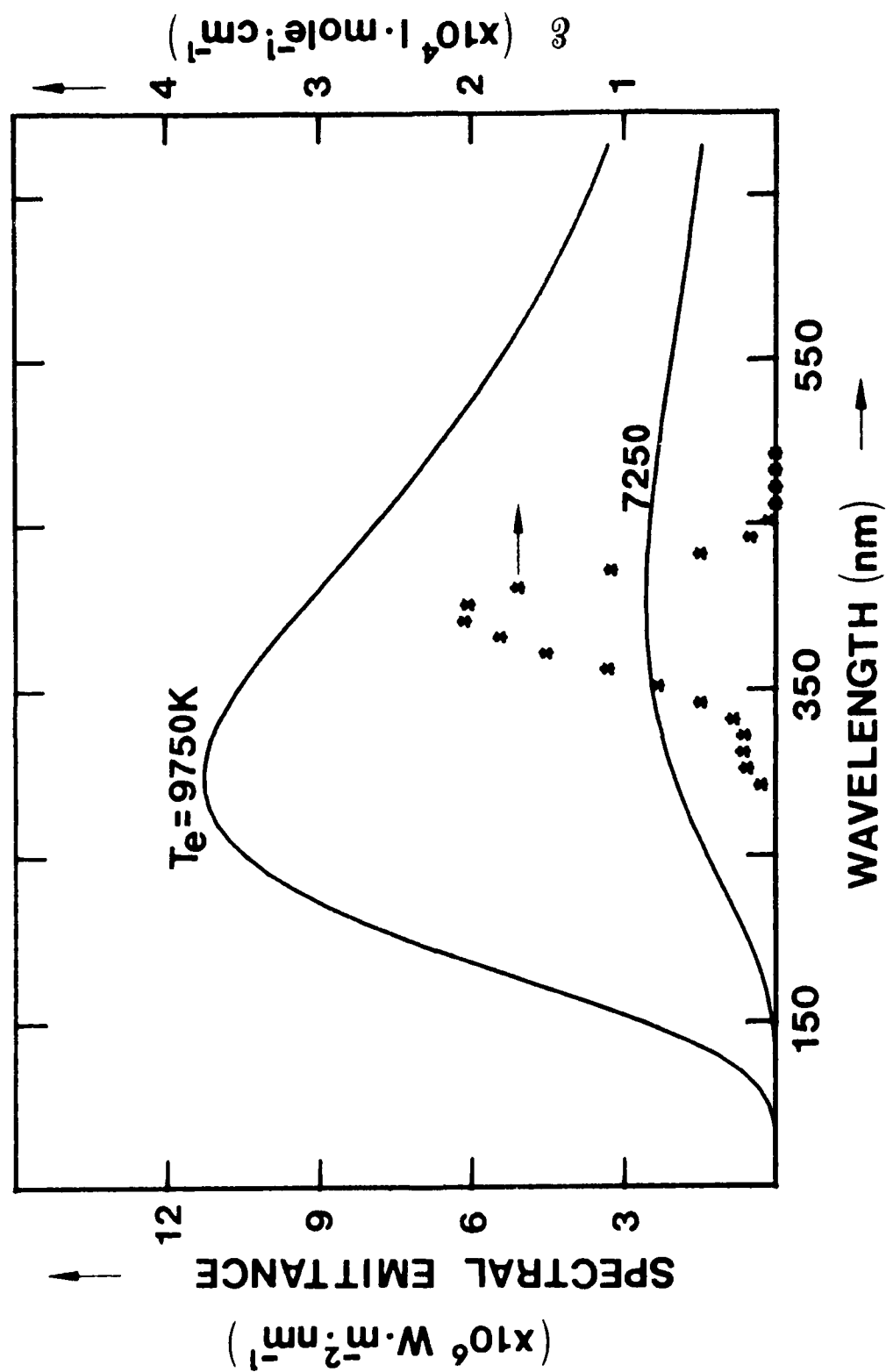


Fig. 1 Spectral radiant emittance of blackbody radiation and absorption spectrum of LD490. 9,750K is a T_{opt} . ϵ ; Molar decadic extinction coefficient.

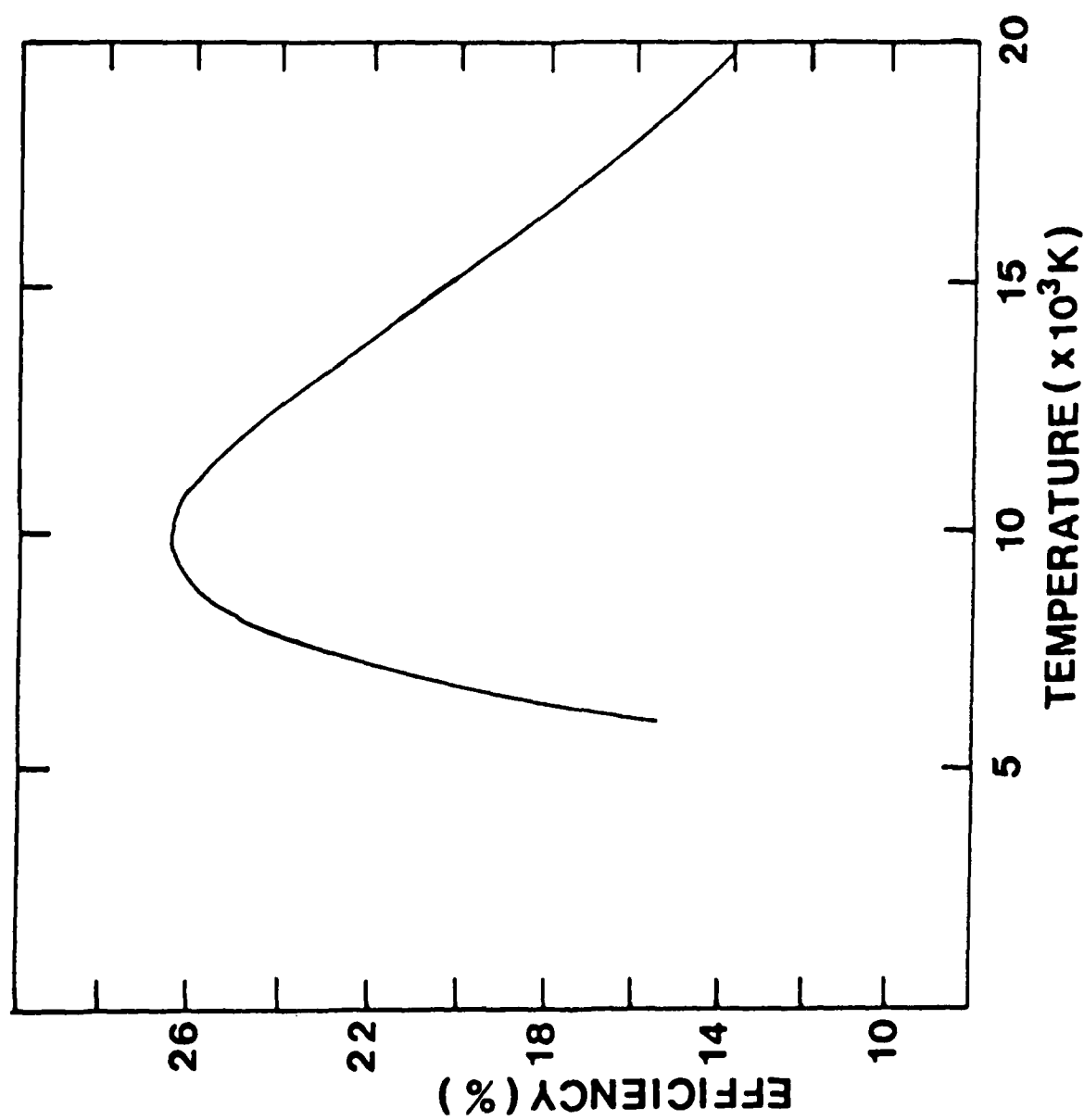


Fig. 2 Absorption efficiency versus blackbody temperature.

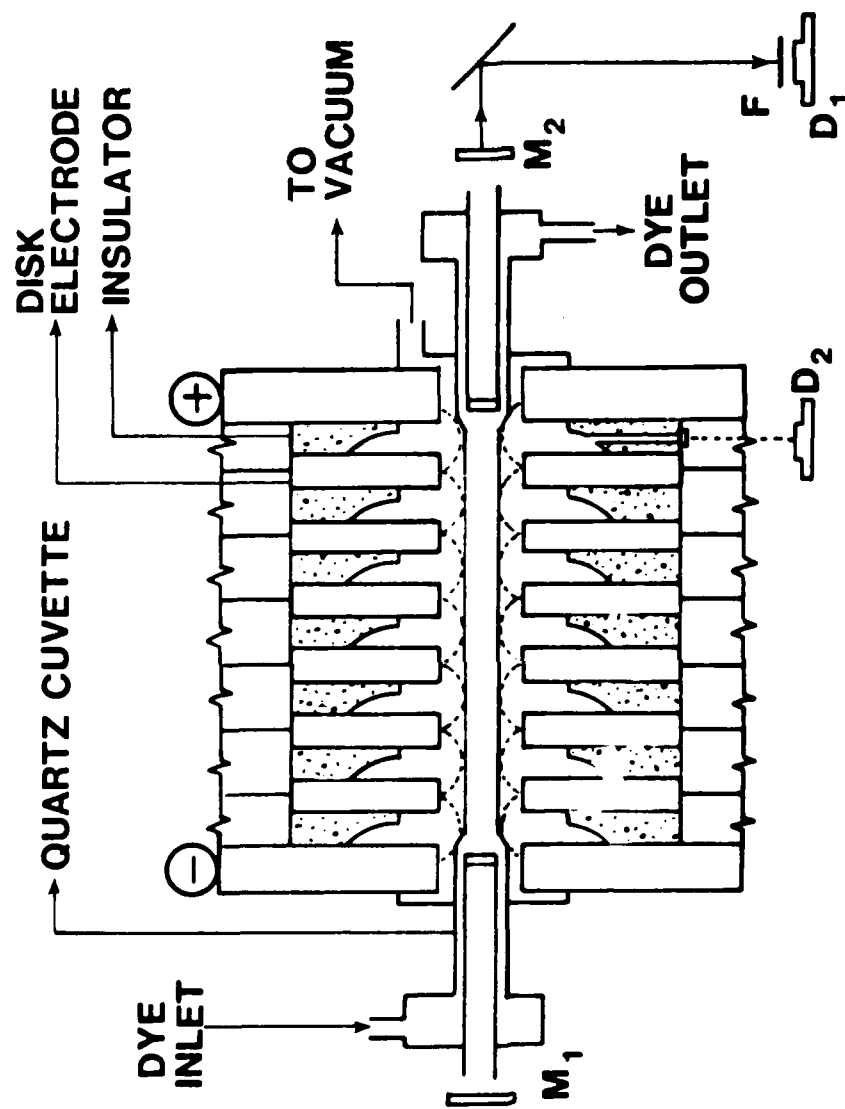


Fig. 3 Experimental arrangement. M_1 and M_2 are dielectric mirrors. D_1 and D_2 are silicon diode photodetectors, and F is the neutral density filter.

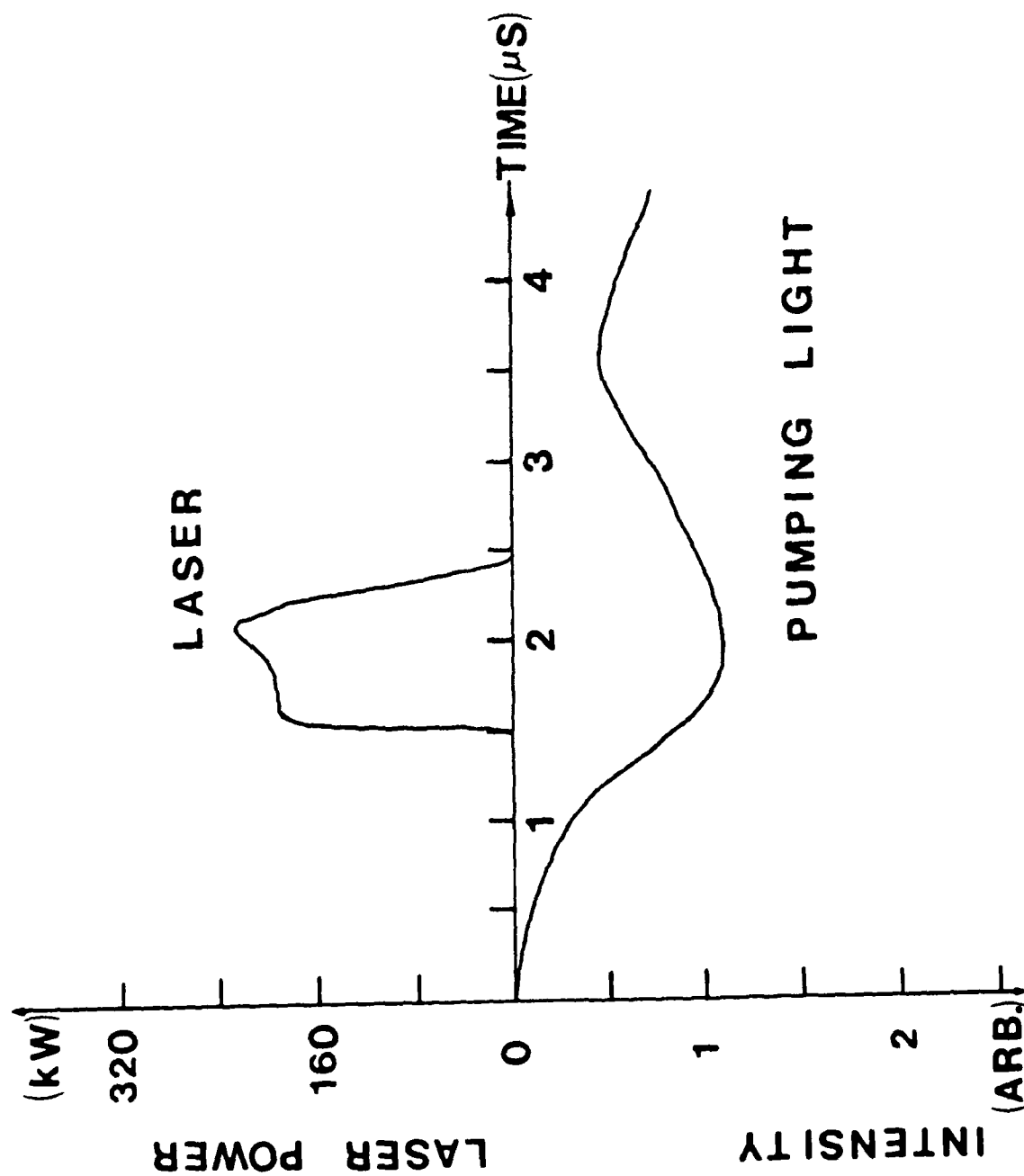


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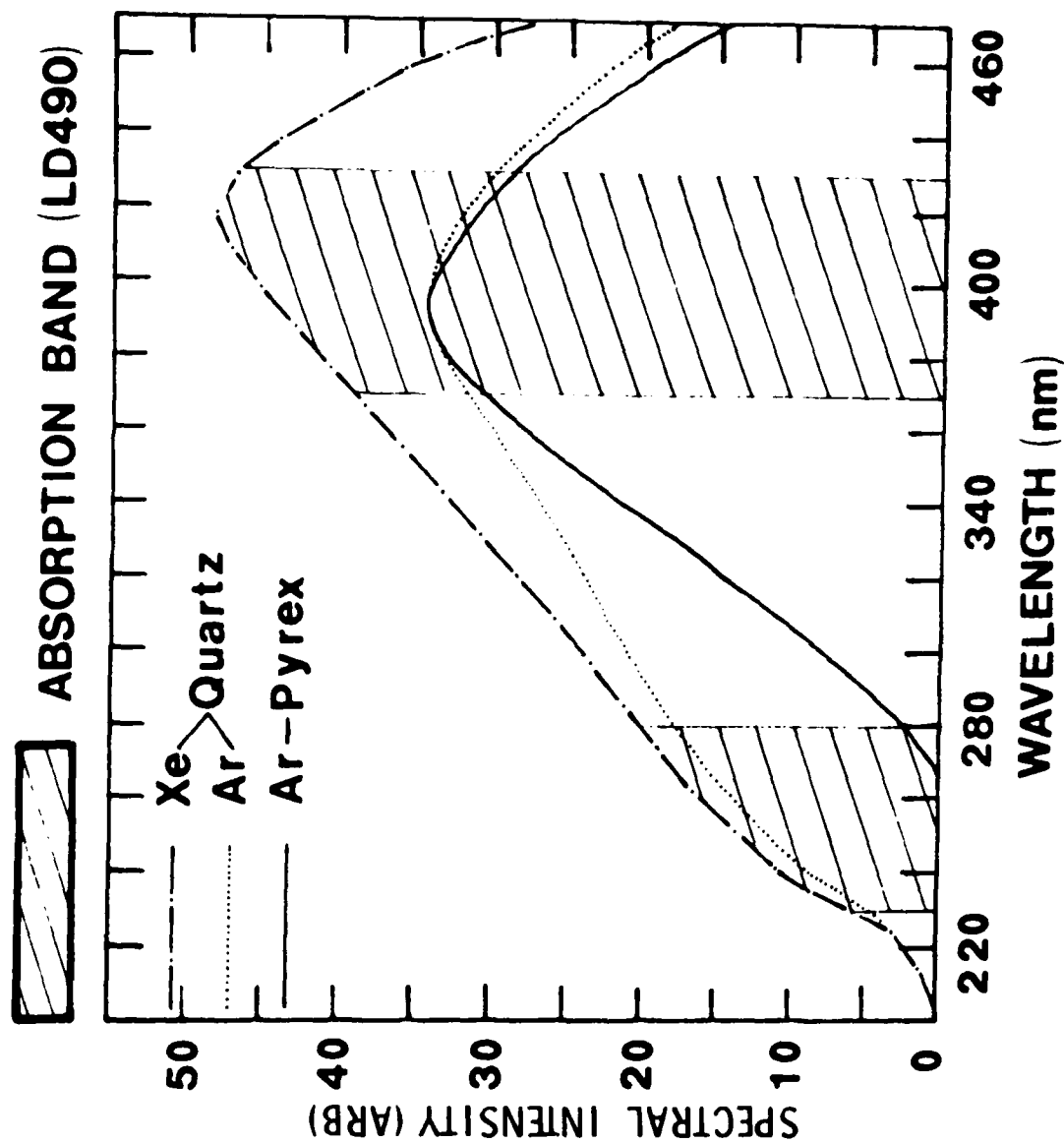


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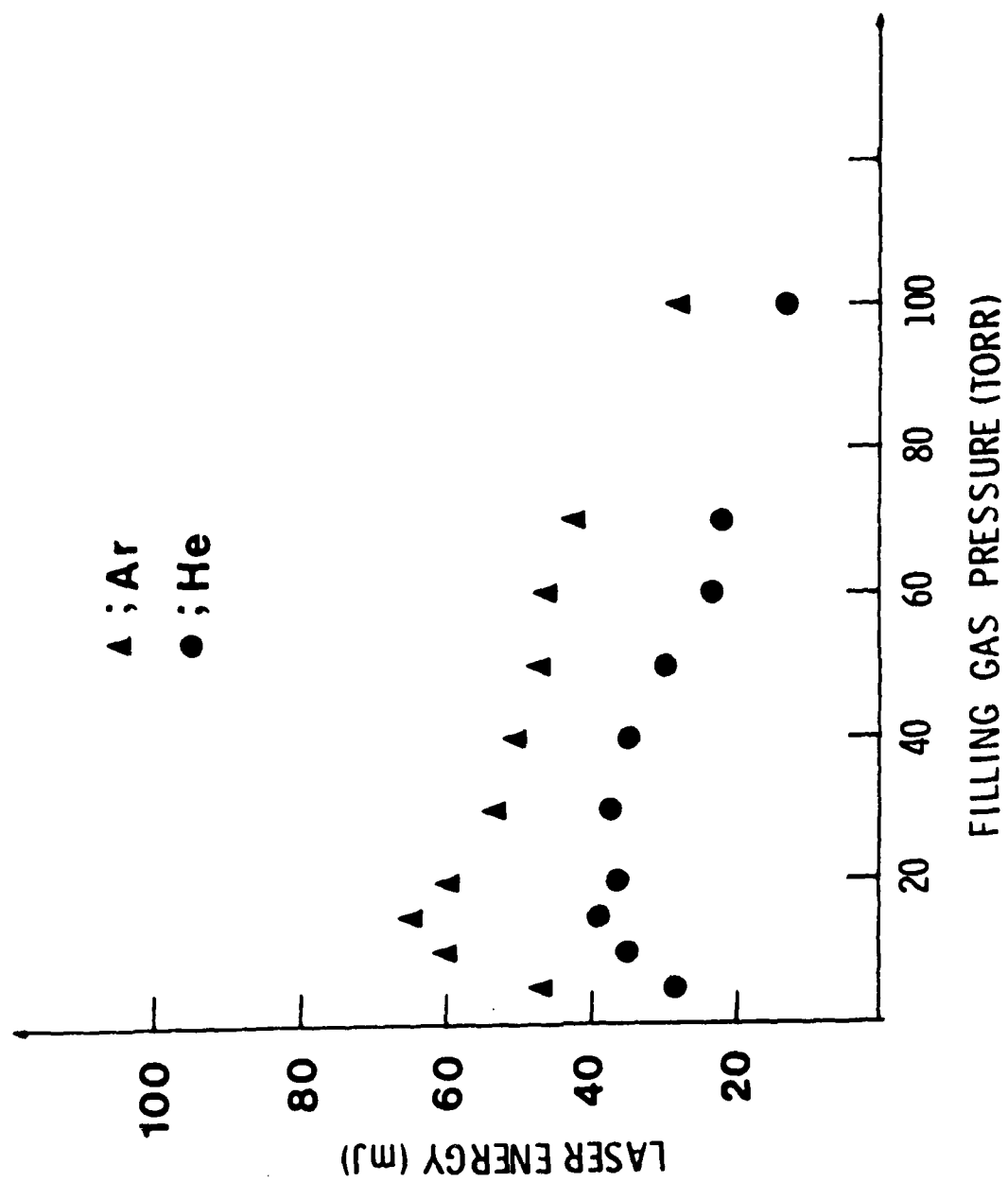


Fig. 6 Laser output as a function of the argon filling pressure.

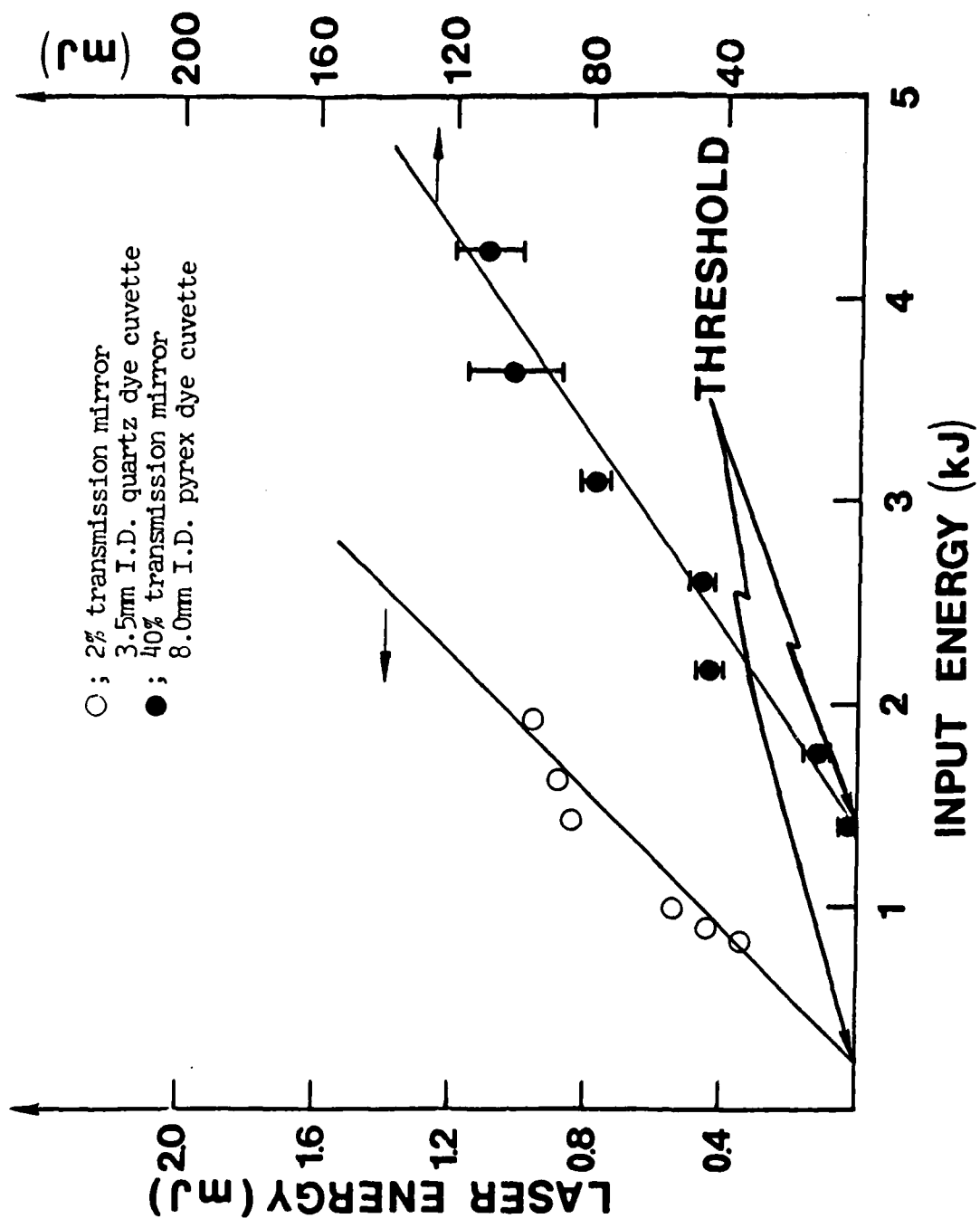


Fig. 7 Laser output as a function of the input energy.

Input energy 1.9kJ
Argon 20 Torr
2% Transmission output mirror
3.5 mm i. d. quartz dye cuvette

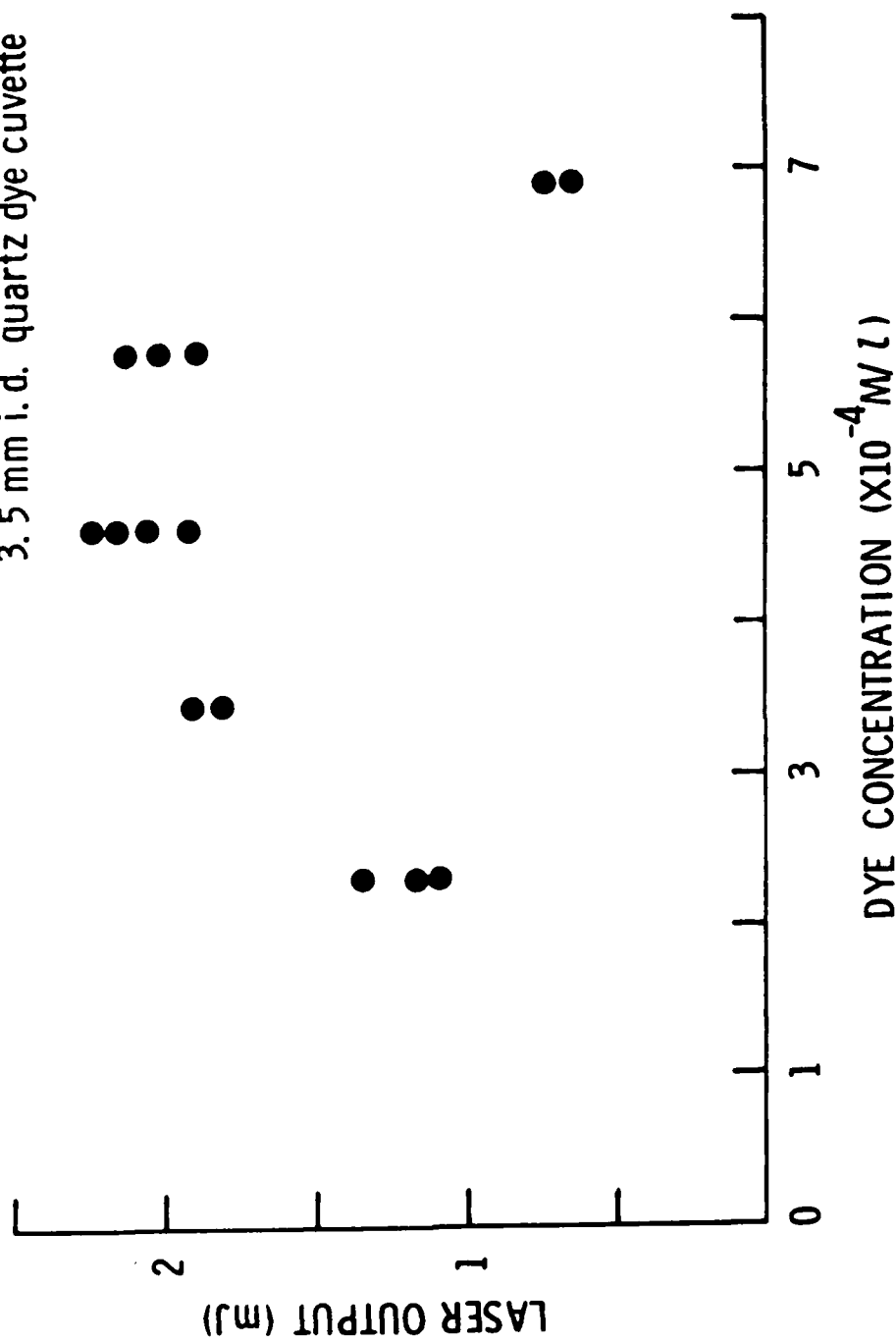


Fig. 8 Laser output as a function of the dye concentration.

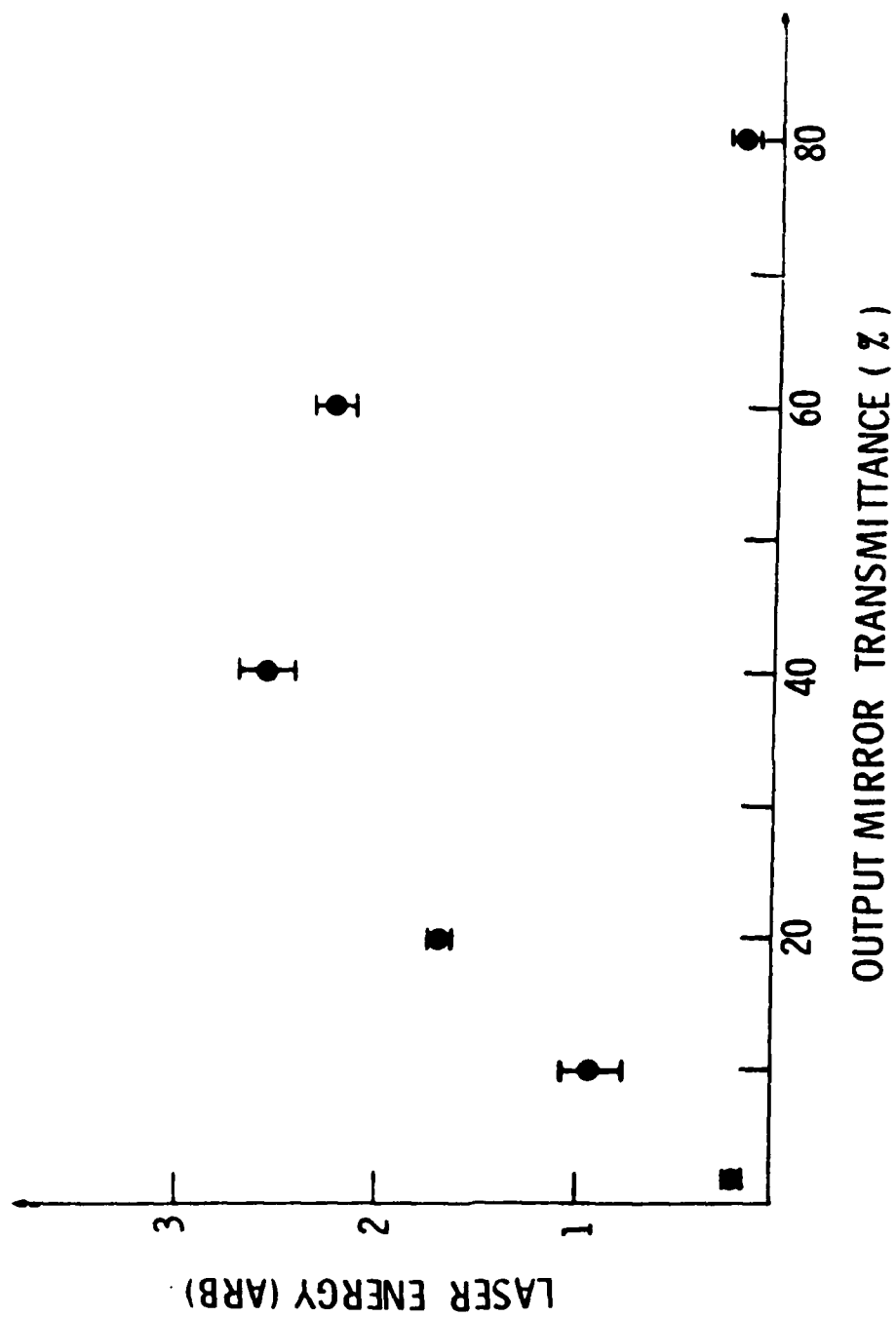


Fig. 9 Laser output as a function of the transmittance of the output mirror.

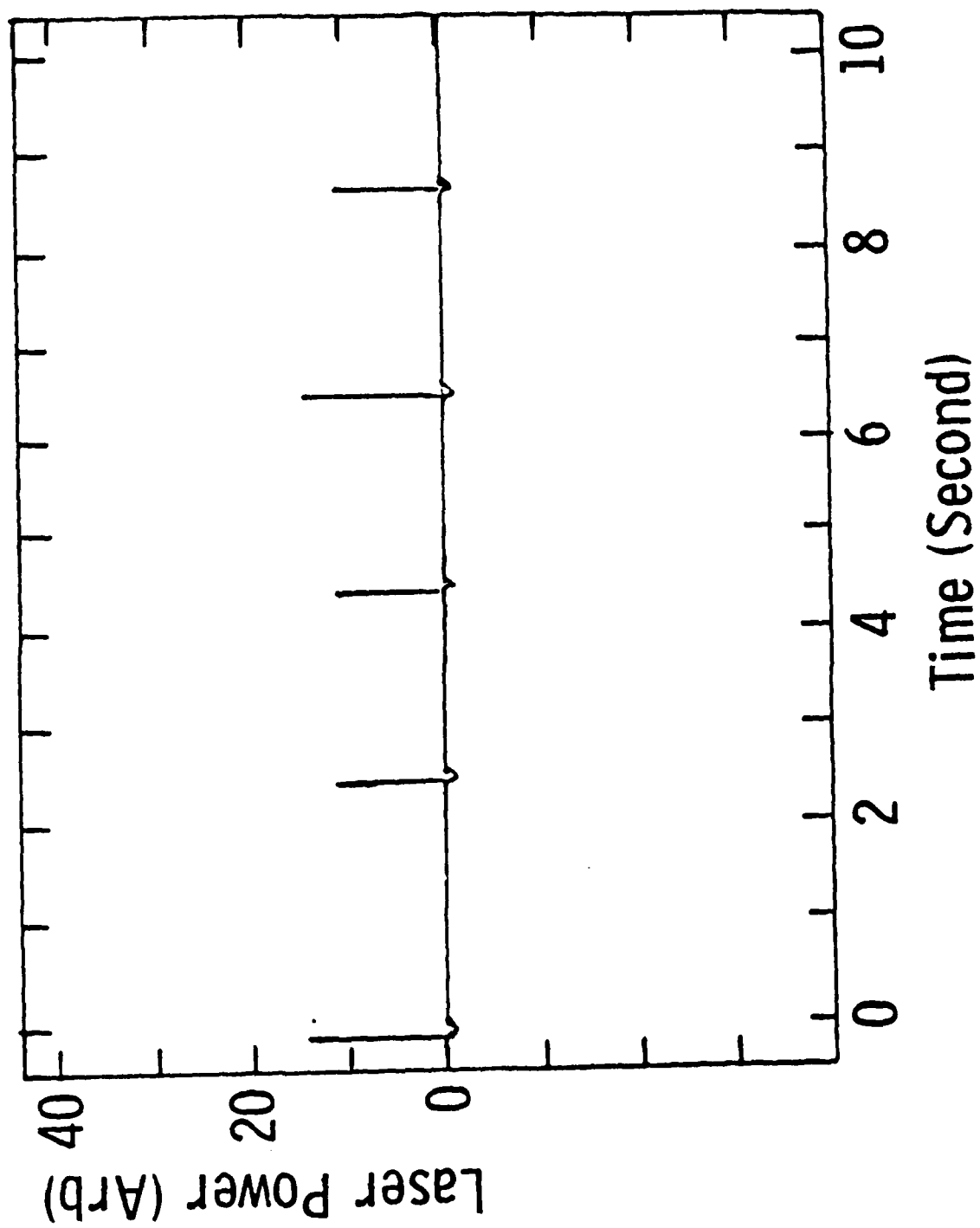


Fig. 10 Repetitive operation of the laser excitation.

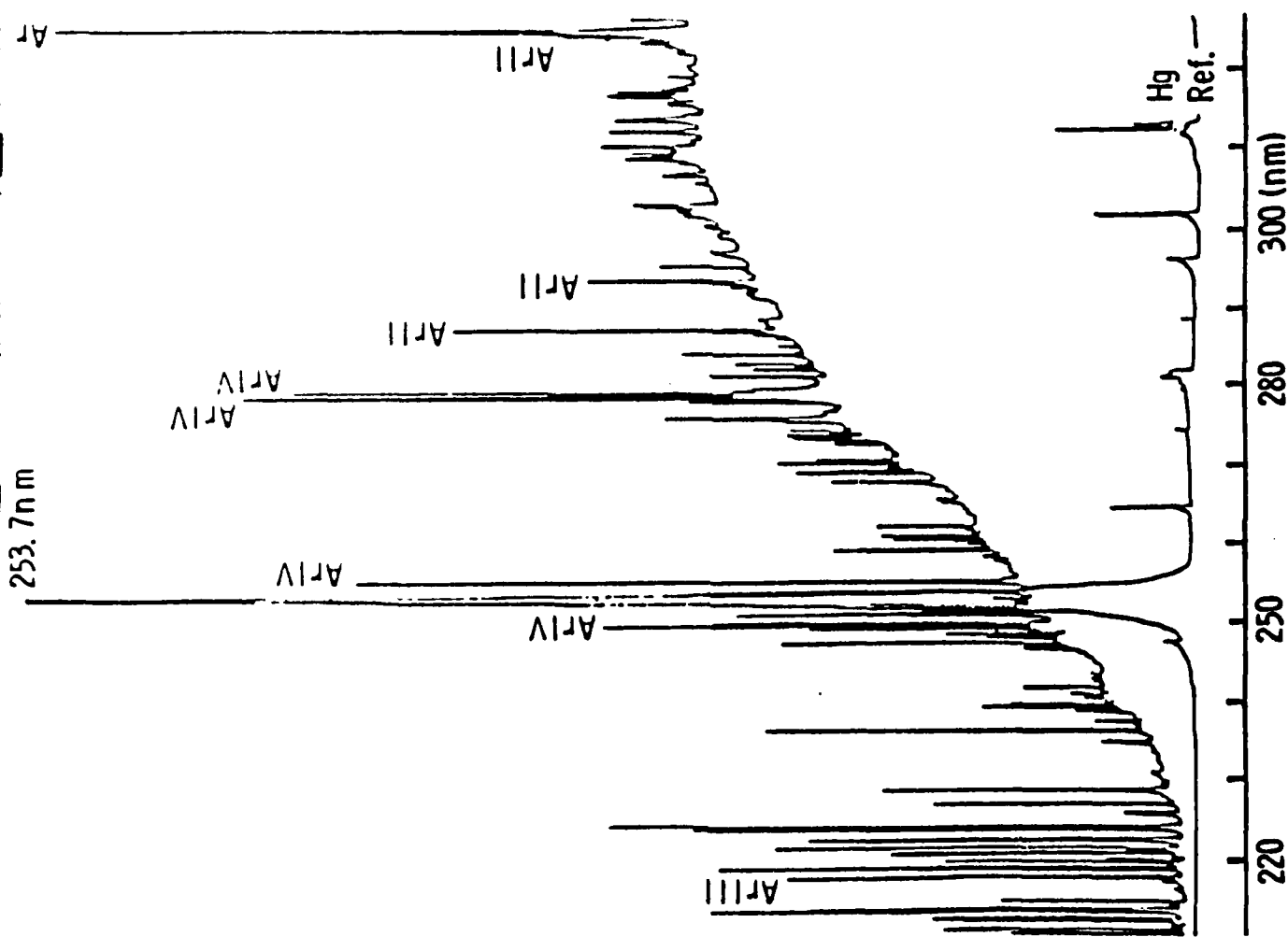


Fig. 11 The microdensitometer trace of the spectrum for argon at 1200 Torr fill pressure. For the calibration of the wavelength mercury spectrum was used.

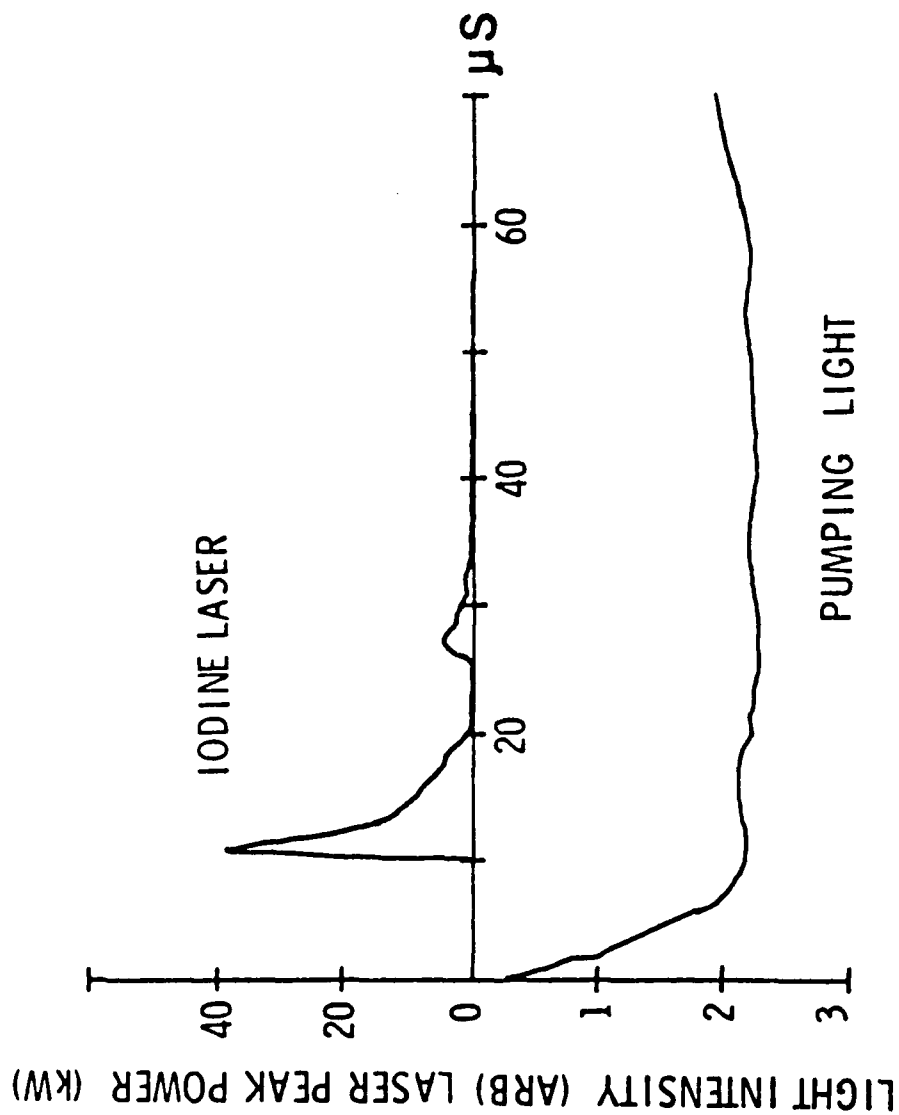


Fig. 12 Oscilloscope traces of the iodine laser and the pumping light signal with the HCP operated at 19kV (8.7kJ), 1.7atm argon fill pressure, and 50 Torr iodide vapor pressure.

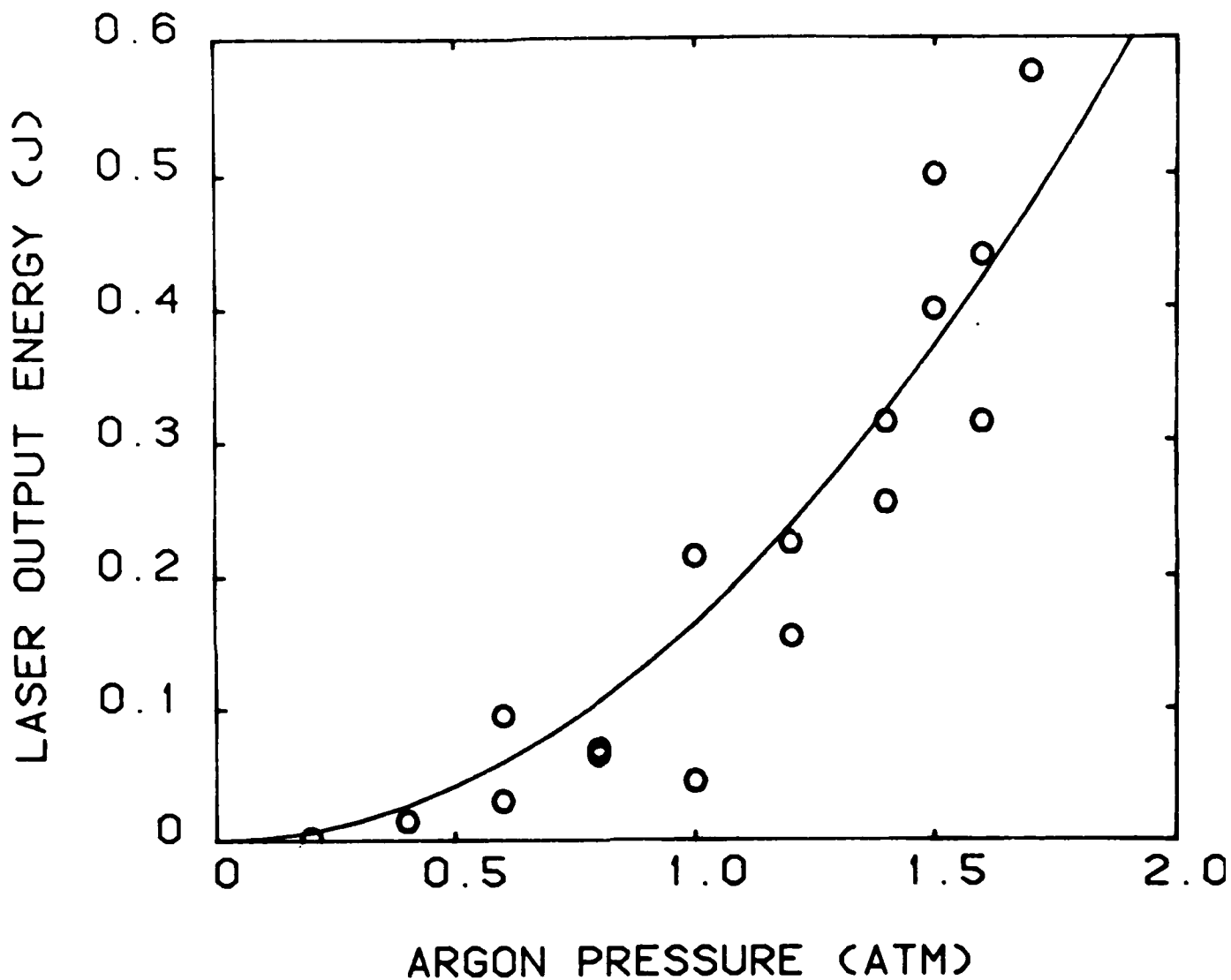


Fig. 13 The variation of the laser output energy as a function of argon fill pressure. The operating conditions were an input energy 8.7kJ (or 19kV), and the iodide vapor pressure at 50 Torr.

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